Modern Lens Design
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L'

Chapter

22

Scanner/f-θ and Laser Disk/Collimator Lenses

22.1 Monochromatic Systems

In a system which is truly monochromatic, the designer is no longer constrained by the need to achromatize the lens system. Thus high-index flint glasses can be used in positive elements and low-index crown glasses can be used in negative elements. This is obviously beneficial as regards the Petzval curvature, and obviates any need to use the expensive lanthanum glasses for the high-index elements. The resulting lens is, of course, a hyperchromat and is suitable only for use with very monochromatic light sources.

22.2 Scanner Lenses

The scanner lens operates with an oscillating mirror which scans the image across the field. To minimize the size of the scanning mirror, the pupil of the system is located at the mirror. An ordinary distortion-free lens has an image height (distance from the axis) which follows the rule $h = f \tan \theta$. When the image is scanned across the field by a mirror with a constant angular velocity, its linear velocity changes; the exposure produced will vary with the velocity. In order to achieve a uniform exposure across the field, distortion is deliberately introduced so that the image position relationship becomes $h = f\theta$. Note that all of the designs in this section have a negative distortion of this type.

The simplest scanner lens is a single meniscus lens, similar to the meniscus landscape lens. A two-element lens with the negative ele-

is a simple three-element lens, in a − + + configuration, with the negative element made of low-index BK7 glass (517-642) and the positive elements made of SF11, an inexpensive, stable, high-index flint. This basic configuration (− + +) is not only nearly ubiquitous, but quite versatile; it has even been used for long-wavelength (10.6-μm) scanners (with suitable materials). A slower, wider-angle scanner lens is shown in Fig. 22.2; here all three elements have the same index, and the order is + − +. Figure 22.3 achieves a higher speed and wider angle by splitting the last element (and shifting some power from the front element). Figure 22.4 is a similar configuration, except that the negative element is low-index BK7. The last of these examples is Fig. 22.5, with a fifth element added on the image side.

The last two scanner lenses, Figs. 22.6 and 22.7, are examples of telecentric systems in which the exit pupil is located at infinity, so that the principal ray of the imaging cone is always normal to the focal plane as the image is scanned across the field. As can be seen, telecentricity not only tends to require a complex design, but also requires that the lens aperture be larger than the image field.

Note that Fig. 20.6 shows a scanner lens with zooming capability.

22.3 Laser Disk, Focusing, and Collimator Lenses

Figure 22.8 shows a typical molded glass laser disk lens. Both surfaces are conics with general aspheric deformations. The lens thickness is important to the design in that it allows for some correction of the astigmatism. At the speed of $f/0.9$ of this example, it is of course vital that the plastic cladding on the disk be included in the design. The actual focal length of this type of lens is to the order of 5 mm, at which focal length the design wavefront aberration is a tiny fraction of a wavelength. This type of lens is often molded in plastic as well as glass.

Figure 22.9 is an airspaced doublet, whose correction is based on the same principles as outlined in Chap. 6 except that, as a monochromatic system, both elements can be made from a high-index flint glass (SF6 805-254). Note that if the configuration is chosen so that the spherochromatic aberration is well-corrected, then the lens can be used for several different wavelengths, although it will require refocusing for each wavelength.

Figures 22.10, 22.11, and 22.12 are examples of spherical-surfaced laser disk lenses. Note that, in each case, the final positive element is spaced well away from the aperture stop in order to allow for a modest correction of the astigmatism. In Fig. 22.12 the designer has com-

(Text continues on page 425.)

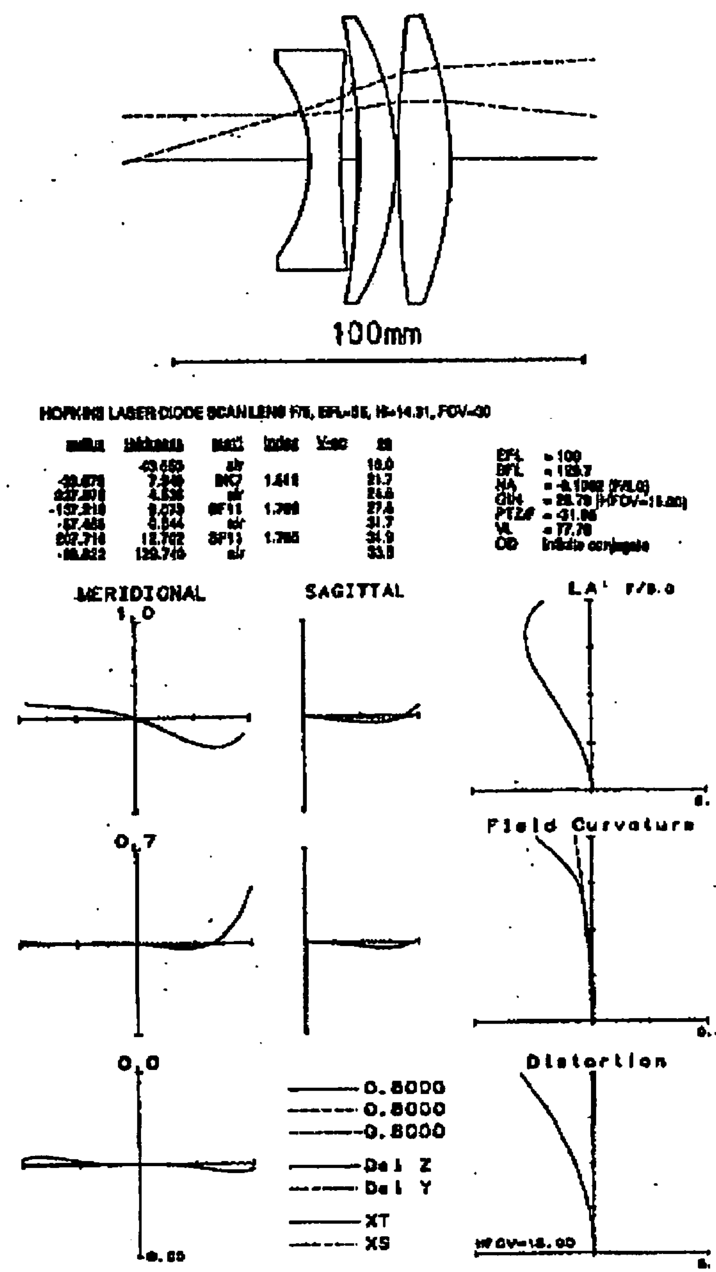
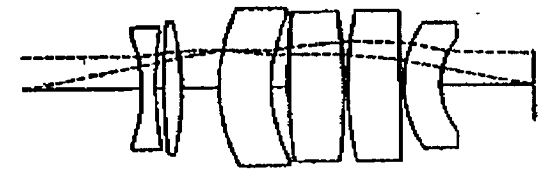


Figure 22.1



100mm

HOPKINS; ME-CD LASER SCAN LENS; F/3.0, EFL=48, FORMAT 16 FOV=19

radius	thickness	mat'l	index	V-no	sa
	57.830	air			0.5
-70.047	6.334	BK7	1.520		27.2
166.615	4.544	air			31.5
290.611	16.430	SF10	1.760		33.8
-118.709	20.835	air			34.3
61.497	34.762	SF10	1.760		40.7
72.819	10.418	air			38.7
124.938	36.633	SF10	1.760		37.1
-214.355	2.084	air			36.6
136.471	30.332	SF10	1.760		36.7
	2.132	air			35.5
62.288	20.839	BK7	1.626		28.5
37.045	62.887	air			24.5

EFL = 100
BFL = 62.9
HA = -0.1667 (F/3.0)
GIH = 16.63 (HFOV=9.50)
PTZP = -13.77
VL = 237.39
OO infinite conjugate

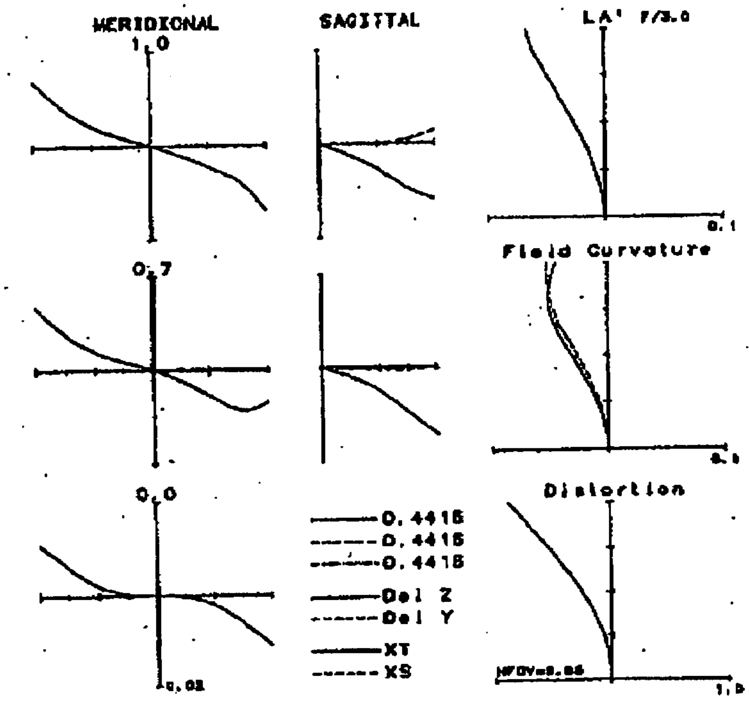
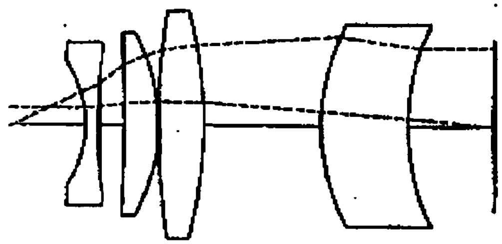


Figure 22.7



100mm

HOPKINS DIODE; F/8.1, Y'=12.5, FOV=45.4, TELECENTRIC IMAGE SPACE

radius	thickness	mat'l	index	V-no	sa
	30.381	air			8.2
-48.237	8.729	BK7	1.511		29.9
263.340	12.710	air			38.1
-1155.849	11.411	SF6	1.764		40.8
-64.815	0.096	air			43.8
322.746	21.053	SF6	1.764		54.5
-102.847	61.888	air			54.5
86.825	44.871	BK7	1.511		48.6
100.396	45.066	air			48.8

EFL = 160
BFL = 45.18
HA = -0.0016 (F/8.1)
GIH = 41.89 (HFOV=22.73)
PTZF = -156.09
VL = 216.30
OO infinite conjugate

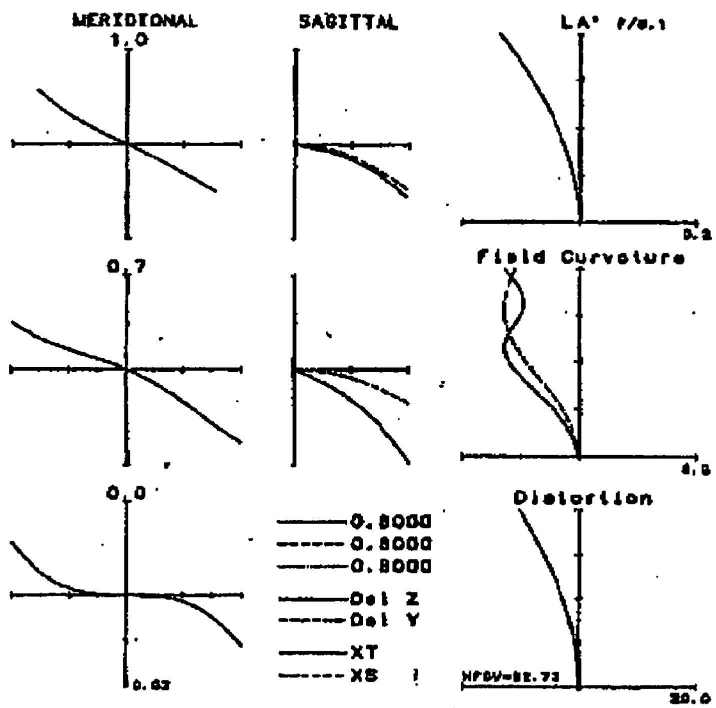


Figure 22.8

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